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CHARACTERISTICS OF MAIN PROTREIN FRACTIONS IN MALE TURKEY MEAT

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ABSTRACT

The characteristics of chemical composition and main protein farctions of deboned turkey meat is presented. It can be concluded that the functional properties of that meat can be more influenced by the total content of protein and the degree of fiber disintegration than by differences in the contents of any specific protein fraction.
Key words: muscle protein, mechanically deboned meat, turkey meat

INTRODUCTION

Turkey meat has wide application in a number of meat products. Breast and thigh muscles are hand-deboned and the meat from remaining parts of the turkey carcass is mechanically deboned. Lately the mechanically deboned meat is widely used in meat products manufacturing (USDA 1994, Lawrence et al. 1984, McCurdy et al. 1986). The characteristics of mechanically deboned meat (MDM) from poultry were reviewed by Froning (1976). Dawson and Gartner (1983) discussed lipid oxidation in poultry MDM. The characteristics of main protein fractions in turkey MDM were not reported.

Myofibrillar proteins are the meat proteins responsible for functional characteristics. The role of myofibrillar proteins in texture, water retention, gelling and tenderness of processed muscle food has been reviewed recently by Xiong (1994). Sarcoplasmic proteins are to some extent capable of positively influencing these properties of myofibrillar proteins (Grabowska and Sikorski 1976, MacFarlane et al. 1977, Kijowski and Niewiarowicz 1978a,b). The role of stroma proteins in affecting the technological properties of meat is not explicitly recognized. Limited cooking time of many meat products does not cause any significant alterations in the transformation of collagen to gelatin, other than shortening and swelling the collagen fibers (Hamm 1972). However, studies have demonstrated that extensive grinding of connective tissue, which occurs during MDM manufacturing, can cause the formation of jelly and fat deposits in communited sausages even at conditions of mild cooking (Ambroziadis and Wirth 1984). The main functional properties of petfood produced by the use of mechanically separated chicken depend mainly on the content of insoluble collagen (Rivera et al. 2000).

Data on the composition of the main protein fractions in poultry meat are still not complete enough to give an explanation of the properties of various poultry meats intended for further processing (Fonkwe and Singh 1994) in opposite to red meat (Boles et al. 2000). Low yield of the extraction procedure of soluble protein fractions in studies of Scharpf and Marion (1964) and Holke at al. (1968) limited the information on protein characteristics in turkey meat. A comprehensive analysis of the main protein fractions, myofibrillar, sarcoplasmic, stroma, coagulated and nonprotein in broiler chicken breast and leg meat as well as in laying hens was reported by Khan (1962) and in breast muscles of broiler chickens by Kijowski and Niewiarowicz (1980). Hand-deboned meat (HDM) from breasts and thighs was expected to be different from MDM, both with respect to the chemical composition and the degree of tissue damage. The parts of turkey carcasses intended for MDM production can be combined in several ways. It was unknown how different raw material composition may influence the main protein fractions in MDM compared with HDM. The objective of this work was to characterize the main protein fractions in various kinds of turkey HDM and MDM.

MATERIALS AND METHODS

The experiment was done in 6 repetitions. To have sufficient amount of raw material for MDM production about 120 turkey carcasses for each repetition were dissected. Carcasses from 22-wk-old, male turkeys, collected in a chilled state from a commercial processing plant were dissected as follows: breast and thigh muscles, drumsticks, wings, skinned necks, backs with breast bones and ribs, and skin from breasts, thighs and thigh bones. The elements of dissected turkey carcasses were kept at the temperatures from 0 to -2^{o}C over night and until sampling on the next day. The randomly selected breast and thigh muscles from 25 carcasses were ground through three successive plates with holes of 10, 5, and 2 mm, respectively. The remaining elements of dissection were used as raw material for production of MDM, applying an AU-4171 type apparatus from Beehive Machinery Inc.,USA.. After 30 to 36 hours post-mortem, meat samples were packed in polyethylene bags, quick frozen, and transported to the laboratory in insulated containers filled with solid carbon dioxide.

The moisture and ash content of the analyzed meat was determined by ISO 1442 and ISO 936 methods respectively, and that of fat by the method of Soxhlet. For total nitrogen and nitrogen of the analyzed protein fractions, the Kjeldahl method was used. The following protein fractions of meat were analyzed: nitrogen of total soluble protein, myofibrillar, sarcoplasmic, stroma, coagulated proteins and nonprotein nitrogen. The nitrogen of total soluble protein was extracted according to Helander (1961) using a 0.1 M phosphate buffer (pH 7.4) with 1.1 M of potassium iodide added. For sarcoplasmic protein extraction, a 0.03 M phosphate buffer was used. Myofibrillar nitrogen was calculated by subtracting sarcoplasmic and nonprotein nitrogen from total soluble nitrogen. Nitrogen from stroma and coagulated proteins were determined according to Khan (1962) using 0.1 M sodium hydroxide for coagulated protein extraction. Nonprotein nitrogen was determined in the supernatant of soluble protein extracts following the precipitation of proteins by trichloracetic acid. Analytical losses in protein fractions analyses were calculated from the differences between total nitrogen taken as a 100% and sum of total soluble, stroma and coagulated nitrogen.

For protein fractionation analysis, 2-g meat samples were taken, placed in conical 100 cm^3 flasks with 25 cm^3 phosphate buffer of molarity respective to extracted protein fraction at 273K (0°C) and extracted by shaking in a water bath with ice. Prior to extraction the samples were triturated with sand. The extract was centrifuged at 9 x $10^3 g$ for 10 minutes and decanted.

These data were examined by an analysis of variance. Arithmetic means and standard deviations from six repetitions are presented in Tables 1 to 3. Mean characteristics were done by Duncan's multiple-range test (Steel and Torrie1960). The relationship between the tested samples was assayed by correlation coefficients.

RESULTS AND DISCUSSION

Table 1 presents the general chemical composition of the analyzed turkey meat. In most samples analyzed, the meat differed in chemical composition with two or three values statistically not different ($P < 0.05$) in each characteristic of the meat. The biggest difference between HDM and MDM was found for fat content in breasts

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and in MDM from turkey frames with skin. Interestingly, in samples of the meat, the ash content in MDM manufactured from turkey frames with or without skin and drumsticks was less than in remaining analyzed varieties of meat including HDM. This was probably due in part to the high level of fat in that MDM. The MDM from wings, however, had a similar level of fat but also the highest ash content. Similar, general chemical composition of turkey MDM was reported by Dawson (1975). Froning et al. (1971), Grunden et al. (1972), and Essary (1979) found more fat and less protein in turkey MDM than in the turkey MDM analyzed in this experiment.

Table 1 Chemical composition of turkey HDM[*] and MDM[*] (%)

	Water		Fat		Protein		Ash	
	X	s	X	s	X	s	X	s
HDM from								
Breats	73,8[b]	0,2	1,9[a]	0,1	23,9[a]	0,3	1,05[ab]	0,02
Thigs	72,7[bc]	0,2	5,4[b]	0,2	21,0[b]	0,2	1,02[bc]	0,02
MDM from								
Neck	76,3[a]	0,7	5,6[b]	0,6	17,2[d]	0,2	0,99[c]	0,02
Wings	69,9[de]	0,9	11,7[de]	1,4	17,8[c]	0,5	1,07[a]	0,02
Drumsticks	71,5[cd]	1,6	9,5[c]	1,3	17,9[c]	0,6	1,01[bc]	0,03
Frames	72,7[bc]	1,9	10,4[cd]	1,4	16,4[e]	0,4	0,88[d]	0,03
Frames with skin	68,8[e]	1,7	14,1[f]	1,3	16,5[e]	0,2	0,90[d]	0,04
Frames with skin and drumsticks	69,8[de]	1,5	12,8[fe]	1,6	17,0[d]	0,2	0,90[d]	0,06

[*]**HDM - hand deboned meat, MDM - mechanically deboned meat,**
x - arithmetic mean, s - standard deviation
[a-e]**Arithmetic means in columns denoted by different letters differ at P < 0.05**

Table 2 presents the content of nitrogen fractions in HDM and MDM, expressed in grams of extracted nitrogen per 100 g of meat sample. The differences between the HDM and MDM with respect to content of total nitrogen and that of fractions of total soluble proteins, and myofibrillar, sarcoplasmic and nonprotein nitrogen are statistically significant ($P < 0.05$). Differences ($P < 0.05$) within the content of the previously cited protein fractions were observed between the HDM from breasts and thighs except for the myofibrillar protein fraction, which was found at the same level in both meat samples. The HDM from breasts showed much higher ($P < 0.05$) content of sarcoplasmic and nonprotein nitrogen than the other meats. The contents of coagulated and stroma proteins were found at similar levels in all samples except for the HDM from thighs, which contained more stroma protein ($P < 0.05$). The level of sarcoplasmic proteins nitrogen was positively correlated to that of non-protein nitrogen in all kinds of meat ($R = 0.969$; $P < 0.05$). The negative correlation ($R = -.891$; $P < .01$) between the level of sarcoplasmic and coagulated proteins would suggest that some sarcoplasmic proteins would become denatured during meat manufacturing.

Different characteristics of nitrogen fractions were obtained for the data expressed as the percentage of total nitrogen (tab. 3). The content of myofibrillar and sarcoplasmic proteins expressed as the percentage of total nitrogen was similar in HDM from thighs and all MDM. The HDM from breasts showed lower content of myofibrillar and higher content of sarcoplasmic and nonprotein nitrogen fractions compared with the other meats ($P < 0.05$). The nitrogen content of coagulated proteins in MDM exceeded ($P < 0.05$) the content of coagulated nitrogen in HDM, probably due to periodic and localized overheating of MDM during processing. The content of stroma protein expressed as a percentage of total nitrogen was similar in all of the meats. No correlations were found between the levels of nitrogen fractions expressed as the percentage of total nitrogen. However, the level of analytical loss was observed to decrease with the increase in total nitrogen ($r = -0.905$; $P < 0.01$) and exhibited a tendency to be higher with an increase in fat content. Because the content of total nitrogen in meat is inversely proportional to fat, a negative effect of fat content on the recovery of protein extracts was observed.

Table 2. Protein fractions in turkey HDM* and MDM*(g of nitrogen/100g of meat)

	Protein fractions													
	Total		Total soluble		Myofibrillar		Sarcoplasmic		Stroma		Coagulated		Nonprotein	
	X	s	X	s	X	s	X	s	X	s	X	s	X	s
HDM from														
Braest	3,79[a]	0,08	3,08[a]	0,07	1,56[a]	0,03	0,91[a]	0,06	0,33[b]	0,06	0,24[a]	0,03	0,61[a]	0,05
Things	3,40[b]	0,08	2,63[b]	0,10	1,61[a]	0,06	0,57[b]	0,05	0,38[a]	0,02	0,27[a]	0,06	0,45[b]	0,05
MDM from														
Necks	2,74[d]	0,08	2,01[de]	0,11	1,30[b]	0,07	0,43[cd]	0,05	0,29[b]	0,04	0,30[a]	0,03	0,28[c]	0,03
Wings	2,87[c]	0,13	2,09[cd]	0,12	1,34[b]	0,04	0,45[c]	0,04	0,29[b]	0,05	0,31[a]	0,05	0,30[c]	0,04
Drumsticks	2,90[c]	0,11	2,14[c]	0,04	1,33[b]	0,04	0,48[c]	0,04	0,31[b]	0,04	0,30[a]	0,05	0,31[c]	0,02
Frames	2,57[e]	0,09	1,86[f]	0,06	1,20[c]	0,06	0,36[e]	0,03	0,28[b]	0,03	0,27[a]	0,04	0,30[c]	0,04
Frames with skin	2,64[de]	0,10	1,91[ef]	0,04	1,24[bc]	0,07	0,38de	0,03	0,28[b]	0,03	0,28[a]	0,03	0,29[c]	0,03
Frames with skin and drumsticks	2,74[d]	0,07	1,98[de]	0,11	1,28[b]	0,05	0,40[d]	0,03	0,29b	0,06	0,29[a]	0,03	0,30[c]	0,03

***HDM - hand deboned meat, MDM - mechanically deboned meat,**
x - arithmetic mean, s - standard deviation
[a-e]Arithmetic means in columns denoted by different letters differ at $P < 0.05$

A comparison between protein fractions in the meat of laying hens and broiler chickens reported by Khan (1962) and Kijowski and Niewiarowicz (1980) and those presented in Tables 1 and 2 shows some similarities. Breast meat of chickens, laying hens and turkeys showed similar levels of myofibrillar proteins. The meat from broiler chicken breasts compared with the breast meat from layers and turkeys showed a higher level of sarcoplasmic proteins. The level of stroma protein was highest in meat from layer breasts, intermediate in turkey breasts and lowest in the breast meat of broiler chickens. The meat from turkey thighs had more myofibrillar proteins, and half as much stroma proteins and sarcoplasmic proteins as meat from the legs of laying hens.

Myofibrillar and sarcoplasmic proteins expressed as a percentage of total nitrogen showed no difference between the MDM and the HDM from thighs. The levels of stroma proteins in MDM and HDM were similar even though the raw material for MDM production is expected to contain considerable amounts of connective tissue. Froning et al. (1973) showed that the amount of collagen in MDM from broiler chickens tends to be stable at a low level regardless of the amount of connective tissue in raw material.

It was concluded that eventual differences in functional properties of turkey meat seems more likely to be influenced by the total protein content and the degree of fiber disintegration than by the differences in the levels of specific protein fractions.

Table 3. Protein fractions in turkey HDM* and MDM*(the percentage of total nitrogen)

	Total soluble		Myofibrillar		Sarcoplasmic		Stroma		Coagulated		Nonprotein		Analytical losses
	X	s	X	s	X	s	X	s	X	s	X	s	X
HDM from													
Braest	81,3^{a}	1,8	41,1^{a}	0,6	24,0^{a}	1,6	8,8^{a}	1,8	6,2^{a}	0,8	16,2^{a}	1,2	3,7
Things	77,5^{b}	3,0	47,6^{b}	1,5	16,6b	1,5	11,1^{a}	0,7	8,1^{b}	1,5	13,3^{b}	1,5	3,3
MDM from													
Necks	73,4^{cd}	1,3	47,6^{b}	2,2	15,5^{b}	2,6	10,5^{a}	1,5	11,0^{c}	2,0	10,3^{c}	2,0	5,1
Wings	72,6^{de}	1,5	46,3^{b}	0,7	15,8^{b}	2,0	10,2^{a}	1,8	10,8^{c}	1,4	10,5^{c}	1,4	6,4
Drumsticks	73,8^{c}	3,9	46,5^{b}	2,5	16,7^{b}	1,8	10,5^{a}	1,2	10,3^{c}	0,6	10,5^{c}	5,3	5,3
Frames	72,4^{de}	3,8	46,9^{b}	1,1	14,0^{b}	1,9	10,9^{a}	2,1	10,7^{c}	2,3	11,6^{bc}	2,3	6,0
Frames with skin	72,3^{e}	4,2	46,7^{b}	1,7	14,5^{b}	3,0	10,6^{a}	1,2	10,6^{c}	1,2	11,1^{c}	1,2	6,5
Frames with skin and drumsticks	72,6^{de}	2,4	46,9^{b}	2,1	14,8^{b}	1,9	10,7^{a}	1,5	10,4^{c}	1,2	10,9^{c}	1,2	6,3

***HDM - hand deboned meat, MDM - mechanically deboned meat,**
x - arithmetic mean, s - standard deviation
$^{a-e}$Arithmetic means in columns denoted by different letters differ at P < 0.05

CONCLUSIONS

1. Only small difference between various MDM was found for crude protein content and much higher difference for fat content.
2. The content of myofibryllar and sarcoplasmic proteins (as the persentage of total nitrogen) was similar in HDM from thighs and all MDM.
3. No correlation was found between levels of nitrogen fraction expressed as the persentage of total nitrogen.
4. A negative effect of fat content on the recovery of protein extracts was observed.
5. The eventual differences in functional properties of deboned turkey meat seems to be more influenced by the total protein content and degree of fiber disintegration (effected by the used method of deboning) than by the differences in the levels of specific protein fractions.

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